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Presence of raccoon (*Procyon lotor*) in Doñana National Park and its surroundings

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Invasive species are known as one of the main factors affecting worldwide biodiversity (Keller *et al*. 2011). Cultural and economical globalization, which have facilitated species movement between remote areas, are involving the incorporation of new exotic species at rates much higher than any other historical period. Currently, this is one of the greatest threats to native communities (Keller *et al*. 2011, IUCN 2011).

The raccoon (*Procyon lotor* Linnaeus, 1758) is a procyonid carnivore with an opportunistic behavior, native from the Nearctic region (North and Central America). Its broad natural range and the high densities which can reach in suburban areas demonstrate a great adaptive success to different ecosystems and a great capability to colonize anthropogenic environments (Rosatte 2000, Kays 2009). The interest of the fur industry on this species and the recent popularity as pets has led to its gradual introduction into the wild in Europe, Central Asia and Japan by means of deliberate or accidental releases (Ikeda *et al*. 2004, Bartoszewicz *et al*. 2008, Kays 2009). Nowadays, several Central European countries already have naturalized populations of this procyonid (Bartoszewicz *et al*. 2008, Beltrán-Beck *et al*. 2011).

Many raccoon records have been reported in Spain so far, mainly from isolated individuals and with higher rates of reports close to densely populated cities (Barona & García-Román 2007, Pinya *et al*. 2009, García *et al*. 2012). In 2007, reproduction of free-ranging raccoons has been confirmed for first time in Spain in the natural park "Parque Regional del Sureste", in Madrid. Despite this region set up a control program of the raccoon naturalized population (Barona & García-Román 2007), due to logistical complexity in the management and eradication of this alien species nowadays two raccoon expanding populations exist in two rivers from Central Spain, Jarama river and Henares river (García *et al*. 2012). Genetic analyses reveal two distinct genetic clusters corresponding to each river, considering 2 effective founders needed for Jarama population and 4 effective founders for Henares population (Alda *et al*. 2011).

In the present study we collect first evidences of the presence of raccoon in Doñana National Park (Doñana NP) and its surroundings (Huelva and Sevilla provinces, SW Iberian Peninsula). These evidences were found by means of accidental findings of tracks and the appearance of individuals photographed during camera trapping campaigns. The first record of raccoon is a track photographed on 05/09/2011 near the place called "Casa de Bombas de Vuelta la Arena" on the very edge of the Natural Park (Ángel Ruiz Elizalde personal

communication; Zone B, Figure 3). In this case there were some old footprints, which probably were made at the end of previous spring. Just a day before, on 04/09/2011, a raccoon was photographed in the "Marismillas" farm land in South-West Doñana NP, during a camera trap campaign conducted by the Doñana NP monitoring team (effort of 2077 traps / night, Zone A, Figure 2 A and 3). Subsequent to these findings, many raccoon trails were found in a stretch of the Algarve stream, included as SIC area (Sites of Community importance, 92/43/CEE) and located outside the Doñana protected areas (Figure 1). This stretch, composed by riparian vegetation, extends from a wildlife underpass in the highway A49 up to 2.5 km to the South, following the course of the stream (Zone C; Figure 3). Several camera trap devices were placed in six different locations in the same stream from 31/10/2011 to 02/12/2011. We used attractive lure for carnivores ("Gusto" Caven, Minnesota, USA) and sardines in vegetable oil as bait. Graphic records of raccoons were obtained in two of these locations separated by 178 m, with a trapping effort of 24 traps /night (Figures 2 B and Figure 3).

Figure 1. Hind track (left) and front track (right) of raccoon, with genet tracks (center). Recorded in the Algarve stream on 25/11/2011, just outside the Doñana protected area (Zone C; Author: X. Fernández Aguilar).

After confirming the presence of raccoon, on 08/12/2011 was conducted a tracking survey in 22 points distributed along 40 km of river course (in the Algarve and Cigüeña streams, and in the Guadiamar river) connecting two of the zones of raccoon presence (Zone B and Zone C, Figure 3). Two of these points were positive on the presence of raccoon tracks (UTM time zone 29: 724274, 4136750 and 726818, 4135080; Zone A Figure 3).

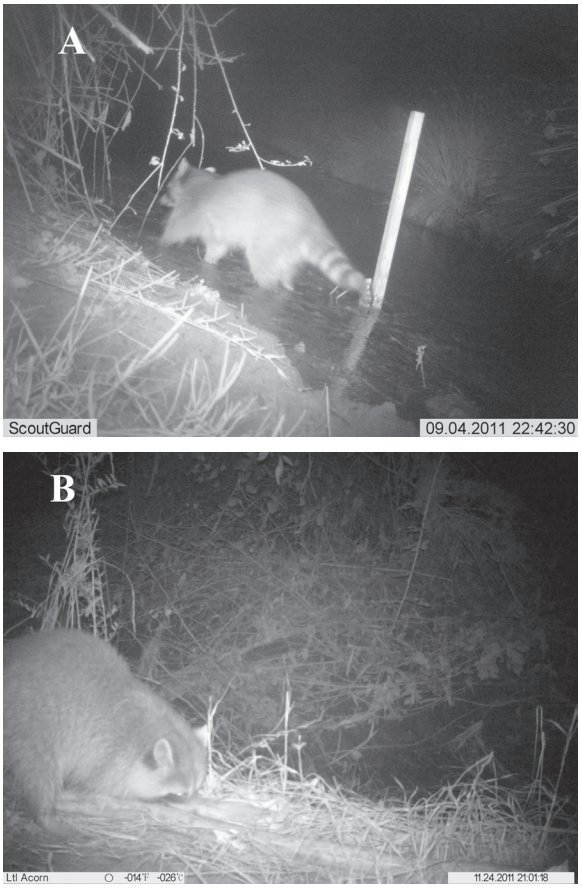

Figure 2. Raccoon images obtained by camera trapping, A: "Marismillas" farm land in the Doñana National Park (Zone A; Author: F. Alberto Carro); B: Algarve stream, just outside Doñana protected area (Zone C; Authors: G. Molina Vacas and X. Fernández Aguilar).

Although results are inconclusive on the presence of more than one individual, this possibility should not be discarded regarding available data about dispersion and home range (Rosatte 2000, Rosatte *et al.* 2007, Bartoszewicz *et al.* 2008, Puskas *et al.* 2011) and considering the spatio-temporal relationship of raccoon records (Zone A-C: 46.9 km, Zone A-B: 20 km; Zone B-C: 27.8 km). However, no raccoon records were obtained by the Iberian Lynx Conservation Team, which set up camera traps in suitable places for the Iberian Lynx *Lynx pardinus (*Temminck, 1827) along the whole Doñana area in 2011 (6.562 traps / night; L. Fernández & F. R. Martínez personal communication).

Since no fur industries are present in the studied area, presumably, these individuals came from pets released into the wild by its owners or by accidental escapes. To avoid more of these cases, the raccoon has been included in the list and catalog of invasive alien species of Spain, covered by the recently approved legislation "Real Decreto 1628/2011",

which establish measures for the prevention and control of invasive species by means of trade restriction within Spain.

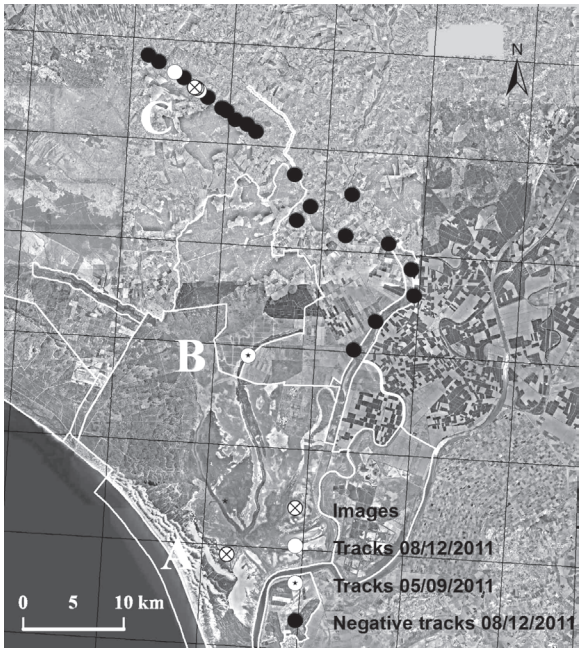

Figure 3. Representation of the sampling points of the tracking survey and location of the raccoon images obtained by camera trapping. The different areas where the presence of raccoon was confirmed are identified by letters (Zone A: "Marismillas" farm land, Zone B: "Casa de Bombas de Vuelta la Arena", Zone C: Algarve stream). The boundary of the protected area of Doñana NP is shown in white.

The invasive potential of the raccoon, which has already demonstrated its ability to settle in Iberian ecosystems (García *et al*. 2007, 2012), is not only worrying about the possible ecological changes in the environment or detrimental effect to other species by means of predation, but is also host and could be a carrier of major infectious and parasitic diseases, including dangerous zoonoses, which can potentially affect both wild and domestic species, and even humans (Allison *et al*. 2001, Sorvillo *et al*. 2002, Beltran-Beck *et al*. 2011). This is of specially concern in a protected environment with a high ecological value as Doñana, which harbor populations of threatened and endangered species as the critically endangered Iberian lynx, which can be very vulnerable to stochastic factors (Thorne & Williams 1988). The settlement of raccoons in suitable ecosystems seems difficult to reverse once produced (Rossate 2000), and it's therefore essential to act with determination in these cases through surveillance, control and removal of the individuals from the wild, as the Invasive Species Specialist Group of IUCN advises. Immediate actions may avoid previous experiences with expanding populations of this alien species in Central Spain or Europe, as well as with other exotic species of mammals recently introduced into Iberian ecosystems, such as the American mink *Neovison vison* (Schreber, 1777), the Barbary sheep *Ammotragus lervia* (Pallas, 1777) or the Coypu *Myocastor coypus* (Molina, 1782), which could be considered already part of the Spanish mammal fauna (Palomo *et al.* 2007).

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